

the methods of calculation, and with the reduction of the observations themselves.

It is our lot to-day to say a few words about another hard worker in astronomical science, whose end has followed too soon after that of Dr. Tietjen. This devoted student of astronomy has been an energetic observer in the same degree that Dr. Tietjen was an ardent computer. We refer to Dr. Friedrich Wilhelm Gustav Spörer, the former chief assistant of the Astro-Physical Observatory at Potsdam, and who died on July 7 last.

Dr. Spörer was born in Berlin on October 23, 1822, and after spending some time at the Friedrich-Wilhelms Gymnasium, he entered the University of Berlin, making mathematics and astronomy his chief studies. On December 14, 1843, he gained his doctor's degree, the subject of his thesis being the comet of 1723. In the following years he worked under Encke's direction at the Berlin Observatory, and in 1846, after having made his Staats exam., went as a teacher of mathematics and natural science to the Gymnasium at Bromberg. In 1847 he proceeded to Prenzlau, and two years later to Anclam, at which latter place he taught for twenty-five years, and became eventually Pro-rector.

It was during his leisure hours there that Dr. Spörer was able to turn his attention to astronomical observations, his instrumental equipment being of a very inferior kind. Notwithstanding this hindrance, he was able, however, by great diligence and perseverance, to make useful observations with regard to the statistics of the solar spots, which have made his name known to every worker of solar physics. Through the attention of Prof. Schellbach, who was the teacher of the then Crown Prince Friedrich Wilhelm, afterwards Kaiser Friedrich, Dr. Spörer was equipped with a good 5-inch telescope, with which he continued to make his solar observations by the known method of projection. His Anclam observations appeared from time to time in numerous articles contributed to the *Astronomischen Nachrichten*, and also in two larger papers which came out in the years 1874 and 1876 in the *Publicationen der Astronomischen Gesellschaft*. The chief value of these pieces of work lies in the careful determination of the elements of rotation of the sun, and also in the more accurate settlement of the then empirically known law of Carrington, namely, the decrease in the velocity of rotation of the sun-spots according to increase of solar latitude.

In the year 1868, accompanied by Prof. Tietjen and Dr. Engelmann, Dr. Spörer took part in the astronomical expedition to observe the total eclipse of the sun visible in the East Indies. Six years later (1874) he received the appointment as observer at the Potsdam Astro-Physical Observatory, and in the same year continued his solar observations from the top of the tower of the Military Orphan Asylum, until the completion of the observatory.

There Dr. Spörer, with untiring energy and with the same ardour that he displayed in Anclam, did a great amount of work in collecting data on the subject of sun-spots. The publications of the Astro-Physical Observatory (years 1879-1894) contain four valuable papers by him, giving a rich quantity of accurate observations that will remain a classical work for the study of the proper motion of the solar spots.

In 1882 Dr. Spörer became chief assistant, and this position he held until October 1894, when he retired for a well-earned rest.

From Dr. Spörer's observations of solar spots, the most important deductions that have been made may be summed up as follows:—

(1) That the period of rotation of the apparent surface of the sun about the axis, is not the same for every part.

(2) That the velocity of the spots is greater nearer the

equator than further away from it, and that this velocity can be approximately represented by a formula.

(3) That the variation in latitude is periodical, and that there are two series of spots. We learn thus that the true sun-spot cycle is one extending over twelve to fourteen years, and that another begins in high latitudes before the former has ceased.

(4) His observations of the quantity of spotted area between the years 1856-1880, show a length of period of eleven years, this being the time between two consecutive maxima.

The maximum is reached when the mean latitude of the spots is about 16° north and south. A retreat then takes place from about 30° to 16° , that is, 14° in four years, and a further retreat from 16° to 8° , that is, 8° in eight years; or, in other words, we get a change of latitude of over 3° a year to begin with, and one of $\frac{1}{2}^\circ$ a year to end with.

Such results as these, which have here only been briefly summarised, are of fundamental importance, and form valuable data for those attempting to investigate the conditions of atmospheric circulation at the surface of our sun. Since the observations have been made consecutively by such a diligent observer, and extend over a considerable period of time, they are strictly of a uniform nature, and in consequence they are comparable *inter se*.

Happy in his work, and endowed with a strong constitution, Dr. Spörer was free from the aillings of old age up to his last day. It was when on a journey to visit his children that he was suddenly seized with paralysis of the heart, without ever having had any previous sign of illness, and died quietly and without pain.

His loss not only affects the astronomical world, but his large circle of friends, all of whom will mourn deeply such a sudden and unexpected bereavement.

W. J. S. L.

NOTES.

CONSIDERABLE activity has been displayed at the Plymouth laboratory of the Marine Biological Association during the present summer, and general satisfaction has been experienced by the naturalists who have visited the station for the purpose of research. Progress has been made with the series of dredging operations in the outlying grounds of the neighbourhood. The unsettled weather of the past two months has been a somewhat unfavourable condition in these expeditions; but it is expected that these operations may be carried on regularly and with increased success during the autumn months. The following naturalists have occupied tables at the laboratory during the summer: Prof. Weldon, F.R.S., Mr. G. P. Bidder, Mr. W. Garstang, Mr. T. H. Rches, Dr. Albrecht Bethe, Mr. W. J. Beaumont, Mr. Gilchrist, and others.

A WELL-MARKED earthquake disturbance was felt at Zermatt on Wednesday, August 21. Many houses were severely shaken.

AMONG the deaths of eminent scientific men abroad, we notice the name of Dr. F. Hoppe-Seyler, professor of physiological chemistry in Strassburg University, and also that of Dr. S. Moos, professor of otology in Heidelberg University.

WE regret to record the death of Dr. J. S. Bristowe, F.R.S., whose work on the "Theory and Practice of Medicine" is recognised as a classic, while his other contributions to scientific literature give him a high place among medical worthies. Dr. Bristowe had filled the offices of President of the Medical Society, of the Pathological Society, and of the Neurological Society. He was elected into the Royal Society in June 1881.

THE Assistant Clerk to the Geological Society, Mr. F. E. Brown, died suddenly on Sunday, August 4. The Society loses in him an invaluable official, who was ever rigid in the exact performance of all his duties, and combined with strict business-like habits a courtesy and patience which endeared him to his colleagues and to the Fellows generally.

THE eleventh Congress of Americanists will be held in the City of Mexico, on October 15-20. The meeting has for its principal object the progress of ethnographical, linguistic, and historical studies of the two Americas, especially with reference to the period prior to the discovery of the New World. Among the matters which will be discussed at the forthcoming gathering are the following:—The relations existing between different American peoples before the discovery; maps of the Atlantic and Pacific Oceans in the sixteenth century; medical natural history of the Ancient Mexicans; public instruction in Mexico in early times, and from the conquest of Mexico to the middle of the sixteenth century; mines and metallurgy before the conquest of Mexico; interpretation of the symbolic dances of the Aztecs; different forms of arrows and their use among the natives of Central America; recent researches with regard to the first appearance of man in America; relationships between the Esquimaux and other native races of North America; prehistoric man in Mexico; the stone carvings in Central America; the pottery of Nicaragua and Costa Rica; the chronological classification of the monuments of Mexico and Central America; the human inhabitants of caves and grottoes; Indian hieroglyphics; names of animals in the native languages of Central America; the decipherment and comparison of the hieroglyphics of ancient races of Mexico; the use of hieroglyphic writing since the conquest of Mexico, and the importance of its study in connection with the Mexican and Mayan languages. The President of the Congress is Sr. J. Baranda, and the Secretary, Sr. T. S. Santos, to whom all memoirs and other communications should be addressed at the Bibliothèque Nationale, Mexico.

DURING the latter part of last week the area of high barometric pressure that had prevailed over the greater part of the British Islands gave way to small disturbances, which either approached from the Atlantic, or were formed immediately over this country, causing severe thunderstorms over England and Ireland, while lightning was also visible in Scotland. In the storm of Thursday night (22nd inst.) the lightning was extremely brilliant in London, the flashes during part of the time being almost continuous. Considerable quantities of rain fell in many localities, and in some of the English districts much damage was done by hail.

THE problem solved by Edison's kinetoscope has been successfully attacked along a different line by MM. A. and L. Lumière. The film which in the kinetoscope takes the impressions of moving objects is passed before the eye with a continuous motion, and it is only illuminated for about a 7000th of a second at the instant at which each successive picture is fully in view. Hence the total illumination is exceedingly feeble. A very bright object is necessary; the eye has to be brought close to the moving film, and the number of impressions per second must be at least thirty in order to give continuity. MM. Lumière's "kinematograph," which is not subject to these disadvantages, is described in the *Revue Générale des Sciences*. The principal features of this instrument are a mechanism whereby the film is at rest during illumination, and an arrangement for projecting the images upon a screen, so as to be visible to a large meeting. Under these circumstances, fifteen images per second are all that is necessary. The film is at rest for two-thirds of the time of passage of each image. During the remaining third the film is grasped and pulled forward as far as

the next image by a set of teeth attached to a frame whose motion is governed by a cam worked by a revolving handle. The same apparatus also serves as a camera for taking the photographs, and for printing transparencies from the negative film. For this purpose two films are passed over the rollers, the negative and the film to be printed on, and exposure is made for a very short time as each negative image is placed in the field. An exhibition was given on July 11, at the offices of the *Revue Générale des Sciences*, at which the evolutions of cuirassiers, a house on fire, a factory, street scenes, and a dinner-party were shown on the screen, and were much admired.

A NUMBER of observations referring to a shower of dust in connection with snow in Indiana and Kentucky, are brought together and discussed in the *Monthly Weather Review*. The dust does not appear to have been the nuclei of snowflakes, but was intermingled in the air with the snow, and fell during an interval between two snow-storms. An examination of numerous samples showed that the dust was made up largely of silt, mixed with organic matter. A number of freshwater algae were distinguished, though they appear to have been dead and dried for some time. There were also groups of diatoms, fungi, animal and plant hairs, fibres of grasses, shreds of woody tissue of some shrub or tree, and many other objects in the samples examined. Everything indicated that the material came from the bottom of some dried-up lake, pond, or marsh, or some river-bottom. To afford information upon the belief that this fine material is very valuable as a fertiliser, an examination of the dust was made from that point of view. The analyses showed that the material is no better fertiliser than any other good surface soil. The dust was almost identical with the so-called "loess" formation, which covers very extensive areas in Illinois, Indiana, Nebraska, and other adjoining States; its depth in some places amounting to a hundred feet or more. This is interesting, because there is a long-standing controversy as to the origin of the loess formation of the North-west. Certain portions of the loess formation of Asia are known to be wind deposits, and there is very strong presumptive evidence, now borne out by the examination of the samples of dust, that much of the loess of the Western States is also a wind deposit. Special interest is thus attached to the dust-storm referred to, on account of the bearing of the observations on the question of the formation of agricultural soils, and especially the loess, which is the lightest and finest of all. This light soil is easily raised and carried by the strong winds of the western plains of America; instances have occurred in which six inches of surface soil have been blown away from freshly cultivated fields in the course of a single wind-storm. Prof. Cleveland Abbe is of the opinion that the dust caught between the two layers of snow in Indiana, probably did not differ materially from that which is daily present in the atmosphere of that region, but its presence on the top of a layer of snow rendered it easy to gather the dust-fall without contamination with the soil already existing. So this dust formation, or loess, when it has once settled upon the ordinary soils, becomes a new ingredient in their composition, and is therefore well worth further study.

A USEFUL bulletin, on the pasteurisation of milk and cream for direct consumption, has been issued from the Agricultural Experiment Station of the University of Wisconsin. It is drawn up by Dr. H. L. Russell, the bacteriologist attached to the station, and contains much interesting matter. There can be no doubt whatever that the pasteurisation of milk is a most important hygienic measure, destroying as it does an average of about 99·7 per cent of the microbes present in milk, amongst which are the diphtheria and typhoid microbes, as well as those organisms associated with gastric and intestinal disturbances so common in young infants during the summer. It is claimed

that the introduction of pasteurised milk among the poor people of New York, through the philanthropic efforts of Mr. Nathan Straus, has done much to reduce the infant mortality in that city during the hot summer months. The practical side of the question has not been lost sight of by Dr. Russell, and the results of his experiments on the efficient production and distribution of pasteurised milk on a commercial scale are carefully brought together. The subject is one of great importance, both from a hygienic as well as commercial point of view, and we may surely hope that before long our dairy authorities will take the matter up, and that we shall follow, though tardily, the example already set us by our neighbours in France and Germany, where pasteurised milk may be purchased across the counter.

THE volume of "British Rainfall" for 1894, compiled by Mr. G. J. Symons and Mr. H. Sowerby Wallis, from observations made at more than three thousand stations in the British Isles, has just been published. As in previous years, the volume contains articles upon various branches of rainfall work, and upon rainfalls of exceptional interest.

DR. TH. WOLF has contributed to the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* (Bd. xxii. Nos. 4 and 5, 1895, pp. 246-265, pl. iii.) a detailed sketch of the Galapagos Islands, describing their geology, in some detail, with shorter accounts of the botany and zoology. He denies that there are any grounds for Dr. Baur's theory that the islands were once connected with the mainland of South America.

WE have on our table the *Journal* of the Royal Agricultural and Commercial Society of British Guiana, containing two papers of scientific interest, viz. "Cane Cultivation in the Straits Settlements," by Mr. F. Campen, and "A Journey to the Summit of Roraima," by Mr. J. J. Quelch; also the *Journal* of the Institute of Jamaica, which, though mostly taken up with matters of historical interest, contains several notes on local natural history topics, and a note on the discovery of aboriginal Indian remains in the Port Royal Mountains, already described in these columns by Mr. J. E. Duerden (p. 173).

THE report of the Royal Prussian Meteorological Institute for the year 1894 draws attention to two points: the completion of the arrangements for magnetic observations at the Potsdam Observatory, and the conclusion of a number of balloon ascents made during the year. The results of these ascents will be made the subject of a special investigation; one of the balloons, sent up with registering instruments only, reached an altitude of over sixty thousand feet. The report shows that many important publications have been issued, both officially, and in various periodicals, by members of the staff; some of these papers have been noticed in our columns. The laboratory experiments carried on by the Institute are of a high order, and have attracted the attention of scientific men in various countries.

THE Royal Horticultural Society's *Journal* for August has in it several important papers. There is a report of the Primula Conference, held a short time back with the idea of increasing and improving the culture of the various species of Primula by procuring new plants from remote regions; by practising the most successful methods of culture; and by producing hybrids. A paper on the botanical work done on the genus Primula since the last conference in 1886 was contributed by Mr. J. G. Baker, F.R.S., and this is printed with one on the culture and classification of Primulas, by Mr. H. Selve-Leonard, and another on the Auricula, by Mr. J. Douglas. Among the other papers in the *Journal*, we notice a long and very valuable description of the plants and gardens of the Canary Isles, by Dr. Morris,

C.M.G., and a paper on the culture of roses under glass, by Mr. F. Cant.

DR. K. SAPPER has supplemented his recent memoir, "Bemerkungen über die räumliche Verteilung und morphologischen Eigentümlichkeiten der Vulkane Guatemalas" (*Zeit. deut. geol. Ger.*, Bd. xlv. 1893), by a further account of the topography of some of the less-known volcanos. (*Petermann's Mitth.* Bd. xli. No. 5, 1895, pp. 105-109, pl. vii.) In spite of the fact that the volcanos of Guatemala have been repeatedly examined during the last half-century, and described in Dollfus and Montserrat's classical work, many of them were almost unknown. Dr. Sapper now describes the volcanos of Acatenango, 3950 m., which consists of five craters in line; San Pedro, 3050m., on which no trace of recent volcanic action remains, for the mountain is wooded to the summit, and the crater has been destroyed; and a group of western volcanos. He was anxious to explore the previously unknown Lacandon, which if proved to be volcanic would fill up a gap in the chain. He was unable to ascend the mountain, but saw sufficient to render it almost certain that Lacandon is a volcano of the first order.

THE Madras Government Museum is, to judge from the Administration Report for the year 1894-95, a very progressive institution. Mr. Edgar Thurston, the superintendent, appears to be sparing no efforts to make the museum more valuable for educational purposes, and for reference in connection with natural history, economic, and other subjects, and also more attractive to the ordinary sight-seer. The increase in the number of visitors to the museum during the year—from 311,112 to 368,282—shows that his efforts are appreciated. We notice with interest, that an entirely new departure was made, during the year covered by the report, by the commencement of a detailed anthropological survey of the races, castes, and tribes which inhabit Southern India. The Madras Government express in the report their satisfaction that the survey has been set on foot. Mr. Thurston has already collected sufficient evidence to make it clear that his investigation will prove of great interest and value.

WHEN Mr. Alfred Daniell's "Text-Book of the Principles of Physics" (Macmillan) appeared, eleven years ago, it was at once hailed as an original work, and a decided acquisition to the literature of physics. The third edition, which is now before us, maintains the characteristics of the original issue. At the time when the work was designed, it was possible for a medical student to obtain the degree of Doctor of Medicine without any adequate knowledge of physics. "That arrangement," Mr. Daniell then wrote, "is self-evidently opposed to common-sense, and to the exigencies of physiological study and of medical practice; such an anomaly cannot, it may be anticipated, endure much longer. Before many years are over, it will be universally acknowledged in practice, as it already is in theory, that knowledge of natural philosophy is an essential part of the mental equipment of the medical student and of the properly-trained medical man." It is satisfactory to be able to record that Mr. Daniell's prognostication was fulfilled in 1892, when the new regulations of the General Medical Council came into force, and it is also gratifying to know that medicine is every day becoming more truly scientific in its methods and objects. Mr. Daniell's work is by no means only suited for a medical class-room; it is alike useful to all students of science. The leading principles of physical science are set forth in the pages of the book in language the precision and accuracy of which make the volume welcome to all who study physics.

WE have received from the Deutsche Seewarte the first supplement to the principal catalogue of its valuable library, which now contains some seventeen thousand works relating to meteor-

logical and kindred sciences, and includes the important collection of the late Prof. H. Dove. It is arranged under subjects, with the titles under each entered according to authors or institutions, while an alphabetical index at the end facilitates the reference to the subject catalogue. Opinions differ as to the best method of publishing such a work, the strictly alphabetical arrangement, such as followed by Prof. G. Hellmann in his excellent *Repertorium der Deutschen Meteorologie*, or the Royal Society's catalogue of scientific papers, possesses great advantages, and obviates the necessity of indexing one book under several sections; but as the Seewarte originally adopted another method, it has perhaps done well to keep to the same plan, and has rendered good service to science by its careful preparation and timely publication of the catalogue. The first part was issued in the year 1890.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Mr. Hugh H. Collis; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. E. Laundry; a Vervet Monkey (*Cercopithecus lalandii*, ♀) from South Africa, presented by Mrs. Edward Webb; two Brown Capuchins (*Cebus fatuellus*) from Guiana, presented by Major W. S. D. Liardet; two Black-eared Marmosets (*Leopoldo benicillata*) from South-east Brazil, presented by Mrs. H. V. Friend; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mr. J. Lewis; a Purple-capped Lory (*Lorius domicella*) from Moluccas, presented by Mr. T. Bailey; two Tarantula Spiders (*Mygale*, sp. inc.) from Trinidad, presented by Mr. J. Hoadley; six Grey Parrots (*Psittacus erithacus*) from West Africa, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), a Ypecha Rail (*Aramides ypechaha*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

REAPPEARANCE OF SWIFT'S COMET.—The *Edinburgh Circular*, No. 44, publishes a telegram from Kiel announcing that Comet Swift was seen by Mr. E. E. Barnard, at the Lick Observatory, on the 20th and 21st inst. The comet is described as faint, and its position and daily motion are given as follows:—

Local Mean Time.	R.A.	Decl.
h. m.	h. m. s.	° ' "
1895, August 21, 11 23.7 ...	0 30 11.4 ...	+ 5 38 55
Daily Motion ...	+ 2.48 ...	+ 10 ...

THE LATITUDE VARIATION TIDE.—One of the most interesting outcomes of the recognition of the variability of the earth's axis of rotation has been the search for the tide, corresponding to the latitude variation. The separation of the axis of rotation from the axis of figure must cause at any point on the earth's surface successive divergences of the sea-level, from that which would exist if the figure of the earth remained a fixed ellipsoid of revolution. This consideration naturally led to the inquiry whether a small oscillation in the mean sea-level could be actually detected, having the same period as the displacement of the pole. The earliest results published were those obtained by Dr. Bakhuyzen (*Astr. Nach.* No. 3261), who used the tidal observations for the years 1855 to 1892, registered on a mareograph at the Helder, and these results showed a satisfactory agreement with those deduced from astronomical observations.

In the meantime Mr. A. S. Christie has been at work on the records made at the United States Coast Survey mareograph stations, and his results, embodied in a paper read before the Philosophical Society of Washington, are now before us. The paper is divided into two sections, the first of which is devoted to the derivation of the formulæ necessary for the elimination of the effects of other tides, and the second contains the results of the application of these formulæ.

The observations employed are obtained from two series, made at stations in the vicinity of San Francisco, namely, at Fort Point (1856-70) and Sausalito (1877-91). Mr. Christie has also used a similar series made at Pulpit Harbour, Penobscot

Bay, Maine (1870-88). It will be sufficient to give here the final result arrived at by combining the results at San Francisco and Pulpit Harbour. The period deduced is 431 ± 4 days, and the value of the half-range tide is 15 ± 2 mm.; while the dates at which the critical phases of the tide occurred are:—

San Francisco.	Pulpit Harbour.
Min., 1872, July 15 ± 15 days ...	1878, August 22 ± 10 days.
Max., 1873, Feb. 15 ± 15 ,, ...	1879, March 25 ± 10 ,,

Dr. Bakhuyzen's value of the half-range is 8.2 mm., a result that does not differ greatly from the mean here given, 15 mm., or from either of the two results, 17.4 mm. and 12.5 mm., on which this value rests.

Reduced to the latitude of Berlin, we have another comparison between the investigations of the American and Dutch astronomers, and the results are still fairly satisfactory, as shown below:—

Julian Date of Maximum Latitude of Berlin.

Bakhuyzen, from astronomical observations 2405141 Julian	
„ from discussion of Helder tides ...	201
Christie, from San Francisco tides ...	153 ± 16

It seems possible, therefore, that this difficult question of the motion of the earth's pole may be attacked by two quite separate processes.

THE SOLAR PARALLAX FROM MARS OBSERVATIONS.—With the view of making a new and trustworthy determination of the solar parallax, a scheme was suggested in 1892 by the authorities of the Washington Observatory for the observation of the difference of declination at the time of meridian passage between Mars and a number of selected stars. The horizontal equatorial parallax of Mars reached in that year a maximum of $23''.4$, a sufficiently favourable condition, though the small altitude of the planet in the northern observatories was likely to introduce considerable uncertainty in the amount of refraction. Among the observatories that replied to the invitation of Washington to take part in this scheme are those of Gotha and the Cape of Good Hope. The result of the combination of the two sets of observations has recently been published by Dr. Paul Harzer, and are of especial interest, since Gotha lies nearly on the northern limit of the region in which observations of Mars could be made with sufficient accuracy.

It was a part of the original suggestion—to which some exception was taken at the time—that in addition to the method of fixing the declination of the centre of Mars by the employment of a pair of wires, separated by about $16''$ to cut off equal segments from the northern and southern limbs of the disc, a reflecting prism should be mounted outside the eyepiece, and that half the observations should be made with, and half without the use of this additional apparatus. The result of the precaution is shown in the following figures, in the case of the two observers who took part in the series:—

	Dr. Harzer.	Dr. Rohrbach.
Mars stars ...	+ 0.253 $\pm$ 0.039 ...	- 0.383 $\pm$ 0.129
Mars ...	- 0.270 $\pm$ 0.091 ...	- 0.523 $\pm$ 0.262

These figures imply that Dr. Harzer placed the stars too low and the planet too high with reference to the threads, Dr. Rohrbach, in both cases, too high.

The observations were continued from June 22 to September 23, and when combined in three groups, formed on the assumption that the error of the ephemeris is constant throughout each group, the resulting values of the solar parallax are—

Group I. ...	$\pi = 8''.680 \pm 0''.081$
„ II. ...	$= 8''.800 \pm 0''.089$
„ III. ...	$= 8''.828 \pm 0''.065$

or combined into one, $\pi = 8''.799 \pm 0''.044$.

The complete combination of the whole series formed into 20 normal places, and in which the possible variation of the error of the ephemeris is also sought, gives $\pi = 8''.800 \pm 0''.039$, and the value of $d\delta$ is expressed in the form

$$d\delta = \frac{-1''.147 + 0''.288t}{\Delta},$$

where t and Δ are reckoned from August 7.000, and the unit for t is 50 days.